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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
DIVISION OF FOREST INSECT INVESTIGATIONS

ANNUAL PROGRESS REPORT OF INVESTIGATIVE ACTIVITIES

CALENDAR YEAR 1951

Forest Insect Laboratory
Coeur d'Alene, Idaho
February 15, 1952

United States Department of Agriculture
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine
Division of Forest Insect Investigations

ANNUAL PROGRESS REPORT OF INVESTIGATIVE ACTIVITIES

Station: Coeur d'Alene, Idaho

Period: Calendar Year 1951
Leader: James C. Evenden

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ANNUAL PROGRESS REPORT
OF INVESTIGATIVE ACTIVITIES
1951[1/]

INTRODUCTION

The project work of the Coeur d'Alene laboratory in 1951 was divided into investigative, or research, activities and those under the Forest Pest Control Act. Progress of the latter dealing with forest insect survey and control programs is not included in this report, but is covered in considerable detail in a separate report entitled "Forest insect conditions in the northern Rocky Mountains, 1951". The present report deals with the progress made on investigative projects during the past year.

At a staff meeting in February, the investigative program of the laboratory was reviewed to appraise the progress on current projects and discuss the need of work on problems not being studied. An attempt was made to set up a comprehensive investigative program based upon the most pressing forest insect problems in the region. These were outlined by work and line projects. Priorities were assigned to each project so that it could be scheduled as to the needs for time of activation, manpower, and funds. The 1951 program of work chose from this listing existing projects which could be quickly terminated or new ones which held promise of considerable progress during the year. It is gratifying to note that 1951 objectives were attained on most of the 7 line projects active during the year.

The 1951 investigative program of the laboratory represents a considerable expansion over those of recent years. This has been effected in part by additions to the laboratory personnel and the separate financing of activities conducted under the Forest Pest Control Act. In view of the urgent need for information on many phases of current forest insect problems, however, the present investigative program is very inadequate. Knowledge on the effectiveness of the ponderosa pine risk rating system is lagging far behind its use in this region. Very little is known on the behavior of the Douglas-fir beetle, the region's most damaging forest insect pest. Spruce budworm infestations now have spread to 1½ million acres in the northern Rockies, yet the conditions under which they should be controlled are not fully understood. These, and others, constitute problems now facing many private, state, and federal timberland managing agencies. Requests are continually being made to the laboratory for solutions to them. It is the aim of the laboratory to gear its investigative program to the earliest possible solution to some of the more pressing problems, but its facilities are such that progress must necessarily be slower than desired.

The progress of line projects active during the year are reported in the following pages under their appropriate work and line project symbols.

1/ Compiled by Philip C. Johnson, Entomologist

PROGRESS AND STATUS OF WORK

WORK PROJECT NO. I-C-1

INVESTIGATIONS OF TREE KILLING BARK BEETLES AND THEIR CONTROL

Line Project I-c-1-1. Tree classification based upon susceptibility to pine beetle attack. James C. Evenden, Philip C. Johnson

Objective

To develop a western white pine risk rating system which will use certain external tree crown characteristics to denote the relative degree of susceptibility of individual trees to mountain pine beetle attack; and to test the mortality ratios of the ponderosa pine risk rating system under northern Rocky Mountain forest conditions.

A. General Conditions Affecting The Project.

The project is concerned with study phases relating to both western white and ponderosa pine forests in the region. For several years the laboratory and the Division of Forest Management Research, Northern Rocky Mountain Forest and Range Experiment Station, have cooperatively studied factors leading to the development of a system of classifying, or rating, individual western white pine trees according to their relative vigor. Further studies have sought to associate vigor with a tree's susceptibility to attacks by the mountain pine beetle. A vigor rating system has been developed and future activities on the project will be directed toward refining the tree characters and testing their efficacy as an index of insect risk.

On the ponderosa pine phase of the study, the main emphasis is in testing the identification, occurrance, and mortality ratios of trees rated according to the ponderosa pine risk rating system. Because the system was designed outside the region, its use here cannot be universally accepted as a tool in bark beetle control until this knowledge is available.

B. Progress During The Year.

White pine phase (James C. Evenden).

A manuscript entitled "A Vigor Classification For Mature Western White Pine in the Inland Empire" has been prepared for publication as a Research Note of the Northern Rocky Mountain Forest and Range Experiment Station.

It is co-authored by C. A. Wellner, research forester of the experiment station, and James C. Evenden of this laboratory. A paper on the same general subject was prepared by the authors and presented by Mr. Wellner before the Forestry Section, Northwest Scientific Association, Spokane, Washington, December 27-28, 1951.

Ponderosa pine phase (Philip C. Johnson).

The 1951 work was divided into 3 parts: (A) the association of the mountain pine beetle and western pine beetle in ponderosa pine, (B) the establishment of risk study plots, and (C) the photographing of pine trees representing all age and risk ratings.

A.) Approximately 30 mature ponderosa pine trees killed by bark beetles during 1950 or 1951 were located and felled for detailed studies of the bole infestation pattern. Because of extremely low western pine beetle populations in 1951 these trees were widely scattered along forest roads in Lincoln and Flathead Counties, Montana. Both counties lie west of the Continental Divide. An equal number of similarly infested trees west of the Continental Divide and a smaller number East thereof were found, but were examined basally without felling them.

Only one mountain pine beetle egg gallery was found in the felled trees, the remainder of the galleries being either those of the western pine beetle or Ips. Similar results were obtained from the basal examinations of standing trees except that mountain pine beetle egg galleries were present to the complete exclusion of western pine beetle galleries in the trees east of the Divide. From observations prior to 1951 it is known that the mountain pine beetle is an important factor in the death of mature ponderosa pine trees in some areas west of the Divide. These areas were not sampled in 1951. The 1951 results are entirely preliminary. They must be supplemented by adequate observations from many more parts of the region before it can be ascertained whether the occurrance of significantly large mountain pine beetle populations will materially affect the results obtained in applying the ponderosa pine risk rating system as an indirect bark beetle control measure in this region.

B.) A series of plots has been planned to 1) provide detailed descriptions of the risk characters of individual trees for comparison with those from trees of similar risk on the Pacific Coast, 2) show any evident change in the risk ratings of trees over periods of time, 3) give in time some indication of the insect-caused mortality in trees of different risk ratings, and 4) serve as demonstrations of the risk rating system. The 1951 work plan for the project called for an examination of operable mature ponderosa pine forests in the region, the selection in them of areas suitable for risk study plots, and the arranging with the land owners of the exclusion of the land from logging for several years and of assistance in establishing the plots in 1952. Five 10-acre plot sites were located in privately-owned tracts of pine and three plots on national forest lands west of the Continental Divide. Although additional plot sites were tentatively located both east and west of the Divide, it was felt that the establishment of eight plots would be all that could be undertaken in 1952. Other plots will be added as the study progresses.

One 10-acre plot was installed in September in an extensive tract of virgin old growth ponderosa pine belonging to the Glacier Park Company, a subsidiary of the Great Northern Railway Company, near Marion, Flathead County, Montana. Company and Western Pine Association foresters and engineers assisted the laboratory in choosing the plot site, surveying the boundaries, measuring and tagging the trees, painting the risk rating symbols on them, and in preparing a complete statistical record of the operation and field data. The Company has planned full protection of the plot for at least 5 years to allow its use by the laboratory in investigative work carried out under this project.

C.) A good start was made on the photographing of ponderosa pine trees representing various age and risk classes. The aim of this phase of the study is to secure representative black-and-white and color photographs of trees in each of the 4 risk ratings and Keen age classes. The photographs will serve to illustrate the features of the rating system in reports and publications and in lectures. Preliminary work consisted of experimental exposures to determine optimum conditions for both black-and-white and color photographs and to study the factors that would assure the maximum visibility of the crown characters upon which the risk rating of each photographed tree was based. The critical lighting conditions needed for good exposures and the difficulty of finding typical examples of risk rated trees suitably isolated in the stand made progress on this phase necessarily slow. The work was done intermittently in connection with other laboratory activities except for a short period late in August when optimum weather conditions prevailed.

C. Present Status

Active and continuing. The white pine vigor classification will need be checked to determine its effectiveness as a measure of the susceptibility of white pine trees to mountain pine beetle attack. Several more years will be needed at the present rate of progress before the installation of facilities to study the effectiveness of the risk rating system will be completed. Additional time then will be necessary to obtain measurements needed for conclusions as to the effectiveness of the system.

Line Project I-c-1-2. Development of western pine beetle control through selective logging in the northern Rocky Mountains. Philip C. Johnson

Objective

To test the application of the principles of sanitation-salvage logging as a means of controlling western pine beetle infestations in the northern Rocky Mountains.

A. General Conditions Affecting The Project.

The accumulation of ponderosa pine timbered acreage cut in sanitation-salvage logging operations in the northern Rockies since 1948 has made it possible to

compare post-logging beetle activities in these areas with those on similar uncut areas. The need for this information is part of an over-all investigation by the laboratory to determine the effectiveness of these cuttings based upon application of the ponderosa pine risk rating system in this region. The study is further facilitated by the cooperation of private and federal timberland owners and managers in making their timber stands and cutting records available to the laboratory. The project is momentarily hampered by an extremely low level of western pine beetle activity everywhere in the region.

B. Progress During The Year

A series of rectangular and roadside plots were established to record periodic post-logging beetle-caused tree mortality in ponderosa pine stands subjected to recent sanitation-salvage cuttings in three areas in Lincoln and Lewis and Clark Counties, Montana. Additional check plots were established in nearby uncut stands to obtain similar records. Detailed stand and loss cruises of the plots were postponed until the spring of 1952 because of the inability to undertake this phase of the work in 1951.

C. Present Status

Active and continuing. Additional sampling units will be required and a sufficiently long series of tree mortality records must be obtained before significant conclusions can be made. Another year or two will suffice to install the needed plots, but a 5- to 10-year period may be needed before sufficient data is secured to terminate the project.

Line Project I-c-1-16. Technical assistance to federal, state, and private timber-managing agencies conducting sanitation-salvage logging operations as a means of preventing destruction of timber resources by bark beetles and other insects. James C. Evenden, Philip C. Johnson

Objective

To furnish advice and assistance in the interpretation and use of tree classifications or rating systems incorporated into timber marking rules to accomplish, among other things, the prevention of abnormal post-logging bark beetle activity in residual stands for stated periods of time.

A. General Conditions Affecting The Project

The use of sanitation-salvage logging has not been formally advocated by the laboratory pending the outcome of investigations into their effectiveness in this region. Encouraged by its success in other regions, Federal, state, and private timber-managing agencies have made a number of cuttings of this kind and are planning more. The laboratory has been called upon by these agencies to advise them in entomological phases of the cutting plans. It is most essential that the laboratory respond to these requests to avoid prejudicing the use of sanitation-salvage logging through faulty procedures.

B. Progress During The Year

Three requests for advice on entomological phases of sanitation-salvage logging techniques were received by the laboratory during 1951. In responding to these requests and providing all available information on their use and benefits, the laboratory carefully pointed out the need for caution in the use of the cuttings until their effective use in this region has been substantiated.

In May, a 2-day school session was held in Grangeville, Idaho under the sponsorship of the U. S. Forest Service, Region One, and the Northern Rocky Mountain Forest and Range Experiment Station. The program developed and conducted by the laboratory included a description of the ponderosa pine risk rating system, field trials of its application, and examples of its use and benefits. The 35 foresters and lumbermen attending the school represented federal and state forestry agencies, pine lumber companies, and associations.

In September the laboratory cooperated with the Western Pine Association in demonstrating field applications of the risk rating system to the forestry and management staffs of the Kalispell Lumber Company and the Glacier Park Company. The consummation this year of the joint sale of a large tract of Glacier Park Company ponderosa pine timber to the Kalispell Lumber Company and J. Neils Lumber Company of Libby, Montana, specifies the use of the risk rating system. With the help of the district forest engineer of the association, the laboratory trained the forestry personnel in the use of the rating system and demonstrated the types of high risk trees to be removed in the sanitation-salvage cutting to management officials of the three companies.

In October the assistance of the laboratory was asked for by the Idaho State Forester and the dean of the University of Idaho School of Forestry in marking high risk ponderosa pine trees on a tract used by the University as a forestry summer camp. A light cut was made to remove trees in close proximity to camp buildings and to leased summer homes on adjacent state-owned lands on the shore of Big Payette Lake, McCall, Idaho. Services provided by the laboratory were provided through the cooperation of the Ogden laboratory. Assistance in risk-rating the trees was given by the Western Pine Association, the Southern Idaho Forest Protective Association, the Idaho State Forester, and the dean of the University forestry school.

Line Project I-c-1- (new). Studies of the behavior of mountain pine beetle infestations in western white pine forests. Philip C. Johnson

Objective

To ascertain and study factors which may affect the initial appearance, fluctuation, or cessation of infestations of the mountain pine beetle in western white pine forests so that control measures can be instituted at such points in the infestation cycle as to insure the greatest effectiveness.

A. General Conditions Affecting The Project

In past years investigative work was done on numerous phases of the mountain pine beetle problem in western white pine forests. Some of the results of these investigations have appeared in laboratory reports and technical publications, but some phases remain to be analyzed and reported upon. The procedures to be developed to undertake this project must necessarily depend to a considerable degree upon the results of these prior investigations. As a preliminary step, completed phases are to be reviewed and present incompleted phases will be brought to some conclusion. Following this, a detailed plan of study will be made for the project.

B. Progress During The Year

The review of investigations of the mountain pine beetle in western white pine carried out to date by the laboratory was scheduled for the winter of 1951-52. This had not been undertaken as of December 31, 1951. A start was made on the summarization of field data not previously reported upon. Mountain pine beetle, parasite, and predator populations per square foot of infested bark were tabulated from 840 trees killed between 1936 and 1939 by (1) year of attack, (2) 2-inch host tree d.b.h. classes, (3) height on tree from ground, and (4) whether they originated on dry, medium-dry, or wet forest sites. The field measurements were obtained by the late Charles D. Bedard in an effort to establish the beetle-parasite-predator relationship in various classes of trees on different pine sites. The above data were taken early in 1951 as an aid in determining what infested trees, if any, could be treated standing on a proposed mountain pine beetle control project. Cancellation of the control project eliminated the need for immediate summarization of these data and this remained to be done at the end of 1951.

From these data it is hoped that objectives other than those of the immediate project will be realized. Of benefit to direct mountain pine beetle control operations, for instance, the data may show such things as the height to which infested trees of various diameters can be treated by bark penetrating insecticides from the ground on various sites without felling, limbing, and bucking the trees. In this type of control the latter operations cost about $14 out of an average total treating cost of $23 per tree. The treating of infested western white pine trees standing offers the possibility of considerable saving in control costs.

C. Present Status

Active and continuing.

Line Project I-c-1- (new). Tests of new insecticides for the control of tree-killing bark beetles in the Northern Rocky Mountains. Archie L. Gibson

Objective

To test and evaluate the toxicity of various formulations of the newer insecticides upon developing bark beetle broods and to develop equipment

and techniques for their application in the economic control of beetle broods; particularly those formulations used as bark-penetrating solutions or emulsions.

A. General Conditions Affecting The Project

The current work of the laboratory under this project is to test insecticidal formulations developed at other laboratories which show promise in controlling tree-killing bark beetle species in this region. The present series of tests are concerned with ethylene dibromide oil solution and emulsion formulations furnished by the Fort Collins laboratory and directed against living broods of the mountain pine beetle in lodgepole pine and the Douglas-fir beetle in Douglas-fir. The use of the EDB fumigant offers hope of more effective treatment of mountain pine beetle-infested trees than the present orthodichlorobenzene oil solutions now used as a bark penetrating insecticide on both standing and felled infested trees. If found lethally effective, the EDB emulsions offer considerable saving in the purchase and transportation of fuel oil carriers on bark beetle control projects in the more remote parts of the region. The prevalence of running streams throughout the northern Rockies makes the field mixing of EDB emulsions simple and inexpensive.

B. Progress During The Year

During the second and third quarters, tests of EDB oil solutions and emulsions were carried out on standing and bucked log sections of mountain pine beetle-infested lodgepole and western white pines. Similar tests with orthodichlorobenzene (ODB) and oil were conducted at the same time. Preliminary results indicate comparable brood mortality with EDB solutions and emulsions and with ODB solutions.

Later in the summer essentially the same tests were repeated using Douglas-fir beetle broods in Douglas-fir. The results of these tests have not been fully evaluated at this time. All tests attempted to show brood mortality by various developmental stages to aid in directing control programs against the most susceptible brood stage should any be determined.

A progress report was prepared on the results of tests conducted with the Douglas-fir beetle in the fall of 1950 and spring of 1951.

C. Present Status

Active and continuous. EDB tests may be concluded in 1952 if satisfactory results are obtained by that time. The project may be activated by the testing of other insecticides as they are developed here or elsewhere.

WORK PROJECT NO. I-c-2

INVESTIGATIONS OF DEFOLIATING, BORING AND SUCKING INSECTS AND THEIR CONTROL

Line Project I-c-2 (new). Studies of the biology and ecology of the black pine leaf scale on ponderosa pine in the northern Rocky Mountains.

Philip C. Johnson

Objective

To investigate the role of insects in the injury or death of ponderosa pine in and near the city of Spokane, Washington, with special reference to the black pine leaf scale, Nuculaspis californica (Aspidiotus californicus).

A. Present Conditions Affecting The Project

Between July 1949 and December 1950 the laboratory cooperated with the Washington Agricultural Experiment Station at Pullman in a study of factors believed to be contributing to the widespread injury and death of ponderosa pine that has occurred since 1947 in the Spokane area. By December 1950 other agencies cooperating in the study had definitely established the pine injury and damage to be due to the effects of airborne fluorides resulting from industrial plant operation in the area. Studies by the laboratory indicated that the scale insect infestation had only a coincident relationship to the isofluors established by these cooperators. The formal cooperative study financed by state, county, and city funds allocated to the experiment station ended with these conclusions. Since then the laboratory's interest in the scale insect problem at Spokane has been an individual effort of an academic nature. Biological data are being summarized, the effects upon continued infestation caused by abnormally heavy brood mortality in March 1950 are being checked, and further leads on the cause of the Spokane epidemic are being investigated.

B. Progress During The Year

Since 1947 when the laboratory became interested in the Spokane scale insect problem, the factor thought to be most responsible for the outbreak was dust. Most of the few known epidemic infestations of this insect species have been associated with dust, most frequently in the Inland Empire with dust in the vicinity of Portland cement plants. Early in 1951 The State College of Washington through its Division of Industrial Research informed the laboratory of the presence of ultra-fine industrial silicon dusts which its air pollution studies showed were present in significant amounts in the Spokane area. Particle size was such that stomatal openings in ponderosa pine needles could conceivably be infiltrated. As the first step in determining whether the silicon dust was associated with the pine leaf scale outbreak, the laboratory arranged for the use of plant micro-technique equipment at the College to check the presence of dust in the needle stomata.

Scale-infested 1950 pine needles from several sections of Spokane were collected and taken to the College laboratory at Pullman in May. Sections were prepared from the needles, using a freezing microtome. Stomatal openings were found to average 15 microns in diameter. Samples of silicon dust furnished by the Division of Industrial Research were measured as small as 1.1 microns with the average not exceeding 5 microns in diameter. No evidence of dust particles were found in the stomatal openings, but the results are not regarded as conclusive. Further investigation of this phase is planned during 1952 with the cooperation of the Division.

A field examination early in the quarter indicated no build-up of the scale in 1951 in most of the Spokane area where the broods were entirely killed by a late spring freeze in 1950. Normal brood development and little change in population density was observed in the relatively small area where survival of the brood during the freeze was considerable. "Burning" of the 1951 pine needles, presumably from atmospheric fluorides, was prevalent throughout most of the areas where such action had been recorded in 1949 and 1950. This was noticed in scale-free areas as well as in the small area where scales persisted in 1951.

C. Present Status

Very limited field work is planned in 1952. The project should be terminated with the preparation by the laboratory of a manuscript to be included as part of a comprehensive published report on the Spokane pine damage study planned by the state college.

WORK PROJECT NO. I-c-3

INVESTIGATIONS OF INSECTS AFFECTING FOREST PRODUCTS
AND THE DEVELOPMENT OF CONTROL METHODS

Line Project (New). Studies of the biology and habits of wood borers attacking felled pole-sized coniferous timber in the northern Rocky Mountains. Philip C. Johnson

Objective

To study the factors favoring the attack by wood borers of felled pole-sized timber; to study the biology and habits of borer species involved in such attacks; and to develop methods to prevent the attacks or to destroy the broods resulting therefrom before their damage renders the poles unmerchantable.

A. Conditions Affecting The Project

The northern Rocky Mountain region is one of the nation's leading source of poles. Hand-peeled western redcedar poles have been "made" in the region for many years. The advent of machine peelers and full length pressure method preservative plants, coupled with decreasing accessibility of cedar pole stands and vastly expanded rural electrification programs, has created a demand for western larch and lodgepole pine poles. Excellent pole stands of both species are very abundant in the region.

The pole industry has been troubled for years by insect problems, particularly those associated with wood borers. Part of the difficulty can be attributed to ignorance or carelessness of the pole operators, part to a general lack of knowledge of the life history and habits of some of the more important pole insect pests. The opportunity to study wood borers in freshly-felled poles in going operations has been very limited, but conditions simulating these were provided in 1950 and 1951 by thousands of acres of larch, lodgepole pine, and spruce uprooted by wind in November 1949. A study under this project has been conducted during the past 2 years to obtain additional information on wood borers attacking the windfelled material.

B. Progress During The Year

Periodic observations of wood borer broods emanating from 1950 summer attacks in the windfalls were concluded in July 1951 coincident with the emergence of new adults. At this time a memorandum was prepared for some of the national forest timber staffs and lumber companies salvaging poles and sawlogs from the blowdown areas. As of July, sawlog degrade from ambrosia beetles and flatheaded and roundheaded borers was not sufficient to limit further salvage of these items. Likewise, the further salvage of lodgepole pine poles was not hindered. Buprestid and cerambycid borers by July 1951

were causing excessive numbers of larch poles to be culled and, in the opinion of the laboratory, prospects of further borer damage appeared good. As a result pole operators in some areas set up procedures recommended by the laboratory for quick on-the-spot checks of borer damage to be made by woods foremen so that these men could appraise the pole salvage prospects in each area prior to logging.

Summarization of life history data was completed only in a preliminary way during the year. Additional determinations on a number of borer species was obtained from the Division of Insect Identification of the Bureau.

C. Present Status

It is planned to terminate present activity under this project by summarizing available information on pole insects and preparing a manuscript on same for the benefit of pole operators in the region.

WORK PROJECT NO. I-c-5

INVESTIGATIONS OF THE SPRUCE BUDWORM AND ITS CONTROL

Line Project I-c-5-(New). Studies of methods of improving the accuracy and general efficiency of spruce budworm surveys. Robert E. Denton

Objective

To study factors that can be developed and used to measure the extent, trend, and severity of spruce budworm infestations.

A. General Conditions Affecting The Project

A long history of spruce budworm infestations has demonstrated the cyclic nature of their occurrence in this region. The natural decline of past outbreaks was not without damage to the affected forests -- damage varying in form from light defoliation only momentarily slowing tree growth to heavy defoliation causing more prolonged loss in increment, deformation, or even the death of the infested trees. The development of applied control measures in the last few years now provides a means of stopping budworm infestations before any great amount of damage occurs. In some instances certain forest uses, such as Christmas tree cropping, demand control at the first signs of budworm infestation. In others, budworm damage can be tolerated in greater amounts before control measures need to be started or while waiting for the outbreak to subside naturally.

Current budworm infestations covering approximately 1½ million acres in the northern Rockies have stimulated a desire for applied control measures. This desire has been furthered by the success of large-scale experimental control

measures in Oregon between 1948 and 1950. At present it may be questionable whether it is feasible or even desirable to consider control measures for every budworm outbreak in the region. There is a need, however, for knowing what outbreaks should be controlled. Unfortunately, present budworm survey methods lack the refinement to adequately portray certain vital features of an infestation upon which control recommendations must be based. Present work under this project aims to develop budworm survey methods that will fit into the laboratory's over-all survey activities under the Forest Pest Control Act.

B. Progress During The Year

It is anticipated that future budworm control recommendations may, in part, capitalize upon the cyclic nature of the outbreaks. This means that in some instances budworm surveys should be able to establish the trend of an existing infestation. The work in 1951 concentrated upon developing trend indices from measurements of (1) overwintering budworm populations, (2) feeding populations, and (3) progress of tree defoliation.

Overwintering budworm populations. Rearing techniques were improved to the extent of controlling excessive humidity changes in the rearing containers. Following a method developed by the New Haven laboratory, heavy paper lining was installed in the 5-gallon paperboard ice cream containers used by the Coeur d'Alene laboratory in rearing the overwintering budworm caterpillars. Emergence of caterpillars from the hibernacula and their subsequent collection was more successful than in previous rearings.

Rearings were again made from bole sections of sapling or pole-sized Douglas-fir trees infested with the budworm in 1950 since previous tests indicated greater population concentrations here than on twigs or branches. Bole sections were obtained from a number of drainages on the Helena National Forest known to contain budworm infestations of various intensities. Emerging budworm caterpillars were tabulated to show variations in over-wintering population densities for subsequent comparison of the same sampling points with late instar populations and the amount of defoliation that might result from their feeding.

To determine variations of overwintering budworm populations on the boles of infested trees, bark sections were taken at various heights on the boles. Average emergence per 100 square inches of bark surface was as follows: midcrown, 62; immediately below the crown, 242; breast height, well below crown, 309. This suggests that in this sampling area the greatest 1950-51 overwintering budworm bole population was near the base of the trees.

Active feeding populations. Efforts to measure the population of early instar caterpillars mining the buds as an index of current budworm population in a given area were not successful. Changes in micro-climate caused by rapid change in elevation, even within a few acres, caused wide variation in the percentage of buds containing young caterpillars. In one test, small caterpillars were found mining 25 per cent of the buds on twig samples. Nearby, but 100 feet up the slope, the percentage of buds being mined was 15, while

100 feet still higher no buds were infested but small caterpillars were found preparing to bore into them. In a similar examination one week later the percentage of mined buds at the same elevational sampling points had changed to 25 (with caterpillars emerged), 26, and 22, respectively. In another test, bud-mining caterpillars were found in 32 per cent of the buds. A week later the same sample showed 48 per cent infested.

These results indicate that budworm populations in the bud-mining stages vary in size even within small areas immediately after hibernation is broken, but that this difference tends to disappear toward the end of the bud-mining period. From a practical standpoint this tendency, if later substantiated, would make it difficult to estimate the possible trend of an infestation or of the subsequent defoliation without several successive counts of bud-mining caterpillars at the same sampling point.

Progress of tree defoliation. Data collected during 1951 indicate that the defoliation this year varied in amount from almost none to nearly 100 per cent. This represented the percentage of 1951 fir needles destroyed by caterpillars overwintering in 1950-51. The aim of this phase of the study was to show the possible relationship between the overwintering budworm population, the active feeding population, and the defoliation caused by the latter. Measurements of each of these three factors taken at 13 sampling points periodically during the season were as follows:

Aver. No. of Caterpillars Per 100 Sq. In. of Bark Surface	Percentage of 1951 Fir Buds Containing Caterpillars	Percentage of 1951 Foliage Destroyed
1	4	2
3	2	1
5	18	50
6	3	2
8	17	30
8	24	70
9	11	50
13	17	20
13	13	50
18	16	58
47	52	92
66	50	96
78	38	98

The above data are not significant to the point that a given defoliation percentage can be predicted from known overwintering or active feeding caterpillar populations, but they do show that heavy overwintering populations, barring accidents, will portend heavy defoliation during the coming season.

C. Present Status

Active and continuing. The 1951 work was the beginning of serious effort to develop budworm survey methods for this region that will be inexpensive, relatively easy to undertake, and provide the information needed for making control recommendations.

Federal Agencies

U. S. Forest Service, Regions 1 and 4
Forest insect investigations especially sanitation-salvage logging tests; surveys and control on national forest lands.

U. S. Forest Service, Northern Rocky Mountain Forest and Range Experiment Station
Forest insect investigations, especially western white pine vigor classification.

U. S. Indian Service
Surveys and control on Indian reservations.

National Park Service
Surveys and control in national parks.

U. S. Fish and Wildlife Service
Surveys and control on game preserves.

U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering.
Cooperation on white pine pole blight study.

U. S. Bureau of Entomology and Plant Quarantine, Division of Plant Disease Control, Blister Rust Control.
Surveys.

U. S. Bureau of Entomology and Plant Quarantine, Division of Insect Identification
Insect determinations.

U. S. Bureau of Land Management
Surveys and control on public domain lands.

State Agencies

Montana State Forester
Idaho State Forestry Department
University of Idaho, School of Forestry
Surveys.

The State College of Washington
Washington Agricultural Experiment Station
Spokane ponderosa pine blight study.

Office of the Governor, Idaho
Office of the Governor, Montana
Control problems.

Cooperators Cont.

City and County Agencies

City of Spokane, Washington
Spokane County, Washington
Spokane ponderosa pine blight study.

Foreign Governments

Canadian Department of Agriculture, Division of Forest Biology
Lodgepole pine needleminer parasite study.

Private Agencies

Western Pine Association
North Idaho Forestry Association
Potlatch Timber Protective Association
Clearwater " " "
Potlatch Forests, Inc.
Twin Feathers Lumber Co.
Ohio Match Company
J. Neils Lumber Co.
Anaconda Copper Mining Co.
Kalispell Lumber Co.
Glacier Park Co.
Northern Pacific Railway Co.
Surveys and control.

J. Neils Lumber Co.
Kalispell Lumber Co.
Glacier Park Co.
Anaconda Copper Mining Co.
Forest insect investigations, sanitation-salvage logging tests.

PERSONNEL

Permanent Employees

Name and Title	Assignment
Swenden, James C. Entomologist, GS-13	In charge of the laboratory.
Johnson, Philip C. Entomologist, GS-11	Assistant in charge of the laboratory. Tree classification. Sanitation-salvage logging effectiveness. Mountain pine beetle infestation behavior. Spokane ponderosa pine blight. Wood borer biology on habits.
Gibson, Archie L. Entomologist, GS-11	Bark penetrating insecticide tests.
Terrell, Tom T. Entomologist, GS-9	In charge of surveys and control. Survey methods.
Trostle, Galen C. Entomologist, GS-5	Surveys and control. Survey methods.
Denton, Robert E. Supervisory Control Aid, GS-6	Spruce budworm survey methods. Surveys and control. Detailed to Fort Collins laboratory August 26 to October 5.
Barber, Miss Violet L. Clerk-Stenographer, GS-4	General clerical duties; correspondence, accounts, property, files, and library.

Temporary Employees

Smith, Glenn W. Supervisory Control Aid, GS-6	Bark beetle survey crew leader. June 16 - September 15.
Koppang, Milton O. Agricultural Aid, GS-5	Bark beetle survey crew leader. Promoted from GS-4 August 19. June 11 - September 28.
Bay, Roger R. Agricultural Aid, GS-4	Bark beetle survey crew member. August 5 - September 29.
Estes, Kenneth M. Agricultural Aid, GS-4	Same as above.

Temporary Employees Cont.

Name and Title	Assignment
Holm, Glenn E. Agricultural Aid, GS-4	Bark beetle survey crew member. August 5 - September 24.
Pfilf, Richard J. Agricultural Aid, GS-4	Same as above.
Scott, David W. Agricultural Aid, GS-4	Bark beetle survey crew member. August 5 - September 19.
Tiedemann, Roland K. Agricultural Aid, GS-4	Bark beetle survey crew member. August 5 - September 24.
Wiggins, Edward I. Agricultural Aid, GS-4	Same as above.
Schultz, Rose E., Camp Cook	Survey crew camp cook. September 2 - 15.

Employees Detailed From Other Agencies

From J. Neils Lumber Company, Libby, Montana

G. D. Welch Timber Cruiser R. J. Hansen Timber Cruiser	Yaak River forest insect reconnaissance survey crew. September 17 - 28.

From Northern Pacific Railway Co., Missoula, Montana

Robert LaBonta Timber Cruiser James Papke Timber Cruiser	Lynch Lake forest insect appraisal survey crew. December 10 - 14.

From Anaconda Copper Mining Co., Bonner, Montana

Al Dawson Forester Ernest Corrick Forester	Lynch Lake forest insect appraisal survey crew. December 10 - 14.

Permanent Personnel on Military Leave

Charles J. Johnson Biological Aid, GS-5	Surveys and control. Spokane ponderosa pine blight. Re-allocated from Supervisory Control Aid, GS-6, 1/17/51. Entered military service 3/16/51.

MANUSCRIPTS AND PROJECT REPORTS SUBMITTED IN 1951

Manuscripts Prepared

Project	
I-c-1-1	Evenden, James C. (and C. A. Wellner) A vigor classification for mature western white pine in the Inland Empire. To be printed as a Research Note by the U. S. Forest Service, Northern Rocky Mountain Forest and Range Experiment Station.
Forest Pest Act (Surveys and control)	Denton, Robert E. The spruce budworm problem in the northern Rocky mountains. Presented at the annual meeting of the Northwest Scientific Association, Spokane, Washington, December 27-28, 1951.
	Trostle, Galen Some problems associated with mountain pine beetle surveys in the northern Rocky Mountains. Presented at the annual meeting of the Northwest Scientific Association, Spokane, Washington December 27-28, 1951.

Project Reports Prepared

I-c-1	Gibson, Archie L. Experiments to test the effectiveness of penetrating sprays against the Douglas-fir beetle. Laboratory report. February 9, 1951.
	Johnson, Philip C. Height of broods as a factor affecting the treatment of standing lodgepole pine trees infested with the mountain pine beetle. Laboratory report. May 7, 1951.
	Results of some methods used to teach the principles and uses of the ponderosa pine risk rating system. Laboratory report. May 11, 1951.
	Some facts about ponderosa pine risk ratings for western pine beetle control. Prepared for distribution to those attending the risk rating school at Grangeville, Idaho, May 15-16. 1951. May 12, 1951.

Reports Submitted Cont.

Project	
I-c-1	Johnson, Philip C. Ponderosa pine risk rating school, Grangeville, Idaho, May 15-16, 1951. Memorandum for files. May 22, 1951.
I-c-3	Johnson, Philip C. Current status of wood-boring insects in windfelled coniferous stands, Kootenai National Forest, Montana. Memorandum prepared for J. Neils Lumber Co., Libby, Montana; forest supervisor, Kootenai National Forest, Libby; and regional forester, U. S. Forest Service, Missoula, Montana. July 6, 1951.
I-c-5	Denton, Robert E. Investigations of the spruce budworm and its control: some applications of the results of forced emergence of hibernacula. Progress report, season of 1950. Laboratory report. May 7, 1951. Spruce budworm conference, Union, Oregon. Memorandum for files. August 2, 1951.
Forest Pest Control Act	Denton, Robert E. 1951 spruce budworm detection survey in the headwaters of Norton Creek, St. Joe National Forest, Idaho. Memorandum for files. July 15, 1951. Evenden, James C. Forest insect conditions in the northern Rocky Mountains, 1950. Mimeographed. January 1951. Information concerning tree-killing forest insects of the northern Rocky Mountains. Mimeographed. April 1951. Preliminary statement of forest insect conditions in Idaho and Montana in 1951. Statement prepared for Western Pine Association. November 13, 1951. Gibson, Archie L. An instance of winter mortality of broods of the mountain pine beetle, 1949-50. Laboratory report. January 25, 1951.

Project

Forest Pest Control Act

Gibson, Archie L.

Examination of treated trees on the Lynch Lake Control Project. Mountain pine beetle in lodgepole pine. 1951. Memorandum for files. December 7, 1951.

Johnson, Philip C., et al.

A plan of forest insect field laboratory activities under the Forest Pest Control Act. Prepared by a committee at Fort Collins, Colorado. February 1951.

Top-killing of ponderosa pine, Kalispell-Columbia Falls area, Montana. Memorandum for Assistant Montana State Forester E.A. Anderson. August 28, 1951.

Forest insect conditions, Glacier National Park, Montana, season of 1951. Laboratory report. September 6, 1951.

Terrell, Tom T.

Tentative program of forest insect surveys, 1951 season. Laboratory report. June 15, 1951.

Reconnaissance survey of Engelmann spruce windfalls in the 1949 blowdown near Lindberg Lake, Flathead National Forest, Montana. Memorandum for files. November 2, 1951.

Mountain pine beetle conditions, Coeur d'Alene National Forest, Idaho, 1951. Reconnaissance and appraisal survey. Laboratory report. November 20, 1951.

Mountain pine beetle conditions, Jack Creek drainage, Beaverhead National Forest, Montana, 1951. Appraisal survey. Laboratory report. December 18, 1951.

Trostle, Galen

Forest insect survey, Custer National Forest, Montana and South Dakota, 1950. Laboratory report. February 8, 1951.

Mountain pine beetle conditions, Kootenai National Forest, Montana, 1951. Reconnaissance and appraisal survey. Laboratory report. November 7, 1951.

Reports Submitted Cont.

Project	
Forest Pest Control Act	Trostle, Galon Mountain pine beetle conditions, Cabinet National Forest, Montana, 1951. Reconnaissance and appraisal survey. Laboratory report. November 7, 1951. Marking the Lynch Lake area for control, 1951. Memorandum for files. December 14, 1951.
Miscellaneous	Evenden, James C. Annual report of investigative activities, Coeur d'Alene laboratory, 1950. Laboratory report. February 26, 1951. Gibson, Archie L. Insects present in western white pine affected by pole blight. Laboratory report. May 24, 1951. Johnson, Philip C. Proposed 1951 research program, Coeur d'Alene laboratory. Laboratory report. March 6, 1951. Program of work, Coeur d'Alene Laboratory, 1951. Laboratory report. May 6, 1951. Assistant Secretary of Agriculture Hutchinson's visit. Memorandum for files. July 26, 1951.